TANG HUMANITAS MEDICINE

Review

Sweet Basil (*Ocimum basilicum*): much more than a condiment

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ABSTRACT

Ocimum basilicum belongs to the family *Lamiaceae* and can be found in tropical Asia, Africa, Central America and South America. It is widely cultivated commercially as a condiment or for the production of essential oil. In this review, this plant is accredited with important effects on health, in addition to being a condiment. In folk medicine it is used to treat vomiting, intestinal colic and diarrhea, menstrual pains and to improve kidney function. Some studies have demonstrated that it can be used for the treatment of hyperlipidemia and also that it has antioxidant, neuroprotective, anti-inflammatory and vasodilator properties as well as hepatoprotective effects. In view of its broad range of effects, further studies should be conducted to ascertain the possible use of this plant in clinical trials, not only for prevention but also as an adjuvant in the treatment of different diseases.

Keywords *Ocimum basilicum*, condiment, traditional medicine, hyperlipidemia, antioxidant, anti-inflammatory

INTRODUCTION

The use of plants can provide an alternative approach for the prevention or treatment of many diseases. Historically, *Ocimum basilicum* (basil) has been used as a condiment and as a folk remedy for the treatment of diseases. This plant, which comprises 50 to 150 species, belongs to the family *Lamiaceae* and can be found in tropical Asia, Africa, Central America and South America. Among the species of the genus *Ocimum*, *basilicum L.* is the one most widely cultivated commercially for its green and aromatic leaves, which are used dry or fresh as a condiment or for the production of essential oil. Because society today prefers natural food additives, naturally derived antimicrobial agents such as basil are gaining increasing importance in antimicrobial packaging (Sappakul et al., 2003; Marotti et al., 1996; Loughrin and Kasperbauer, 2001; Hossain et al., 2010; Venancio et al., 2011).

Basil is traditionally used worldwide as a medicinal herb to treat numerous ailments. The leaves and flowering parts are traditionally used as antispasmodic, aromatic, carminative, and digestive remedies, and to treat abdominal cramps, gastro-enteritis, fever, poor digestion, nausea, migraines, insomnia, depression and dysentery. They have been applied externally to treat acne, insect stings, snake bites, and skin infections (Loughrin and Kasperbauer, 2001; Kaya et al., 2008; Venancio et al., 2011; Bora et al., 2011).

The high cost of pharmaceutical medications has led to an increasing search for alternative medicines to treat numerous diseases, which are usually easier to find and less expensive. In view of this trend, there is a need for studies confirming the effects of medicinal plants and phytotherapeutic products. The purpose of this review is to show that many studies have demonstrated that *O. basilicum* has various beneficial effects on health and that it deserves to be researched more extensively in clinical trials for use in prevention and treatment, or as an adjuvant in the treatment of numerous disorders.

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ESSENTIAL OILS OF *OCIMUM* SPECIES

The essential oil of the *Ocimum* species can be extracted from the leaves and inflorescence tips by hydrodistillation and major constituents are linalool (40.5 to 48.2%) and methyl chavicol (estragole) (28.9 to 31.6%) (Fleisher, 1981; Padalia and Verma, 2011).

Vieira and Simon (2000) made a chemical analysis of *Ocimum* species used in Brazilian folk medicine. The species *O. gratissimum* showed a high percentage of eugenol (40 - 66%) and thymol (31%), while *O. campechianum* showed a high content of 1.8-cineole (62%) and β-caryophyllene (78.7%). *O. americanum* presented a high methyl content (> 90%) and the main constituent of *O. selloi* was found to be methyl chavicol (approximately 40%). *Ocimum basilicum* was found to contain 1.8-cineole (22%), linalool (49.7%), methyl chavicol (47%) and methyl cinnamate (65.5%).

Zhang et al. (2009) identified linalool (about 30.0%) and (Z)-cinnamic acid methyl ester as the main components, followed by cyclohexene, alpha-cadinol, 2,4-diisopropenyl-1-methyl-1-vinylcyclohexane, 3,5-pyridine-dicarboxylic acid, 2,6-dimethyl-diethyl ester, beta-cubebene, guaia-1(10),11-diene, cadinene, (E)-cinnamic acid methyl ester and beta-guaiene in essential oil of the aerial parts of *O. basilicum* L.var. pilosum.

Padalia and Verma (2011) studied four *Ocimum* species from India and found that the essential oil from *O. basilicum* has chavicol (68%) and linalool (21.9 to 25.6%) as its major compounds. The major compound found in *O. gratissimum* and *O. sanctum* was eugenol (77.2%), while those found in *O. kilimandscharicum* were monoterpenoids (95.8%) such as camphor (64.9%), limonene (8.7%), camphene (6.4%) and (E)-β-ocimene (3.0%).

Table 1. Some of the compounds in *Ocimum* species and their pharmacological effects

Compound	Effect reported	Reference
Chavicol	Antioxidant	Mohamad et al., 2011
Linalool	Antioxidant	Karimian et al., 2011
Eugenol	Antioxidant, antiperoxidant	Samarth, 2007; Huang et al., 2011
Thymol	Antioxidant	Karimian et al., 2011; Huang et al., 2011; Wu et al., 2012
Flavonoids	Antioxidant, radical scavenging activity, anti-inflammatory	Samarth, Samarth, 2009; Oliveira et al., 2012
Steroids	Antioxidant	Samarth, Samarth, 2009; Oliveira et al., 2012
Saponins	Cardioprotective effects	He et al., 2011; Wintola, Afolayan, 2011
Tannin	Cancer prevention, treatment of inflamed or ulcerated tissues	Okwu, Emenike, 2006; Ruch et al., 1989

Verma et al. (2011) analyzed the composition of the essential oil from two cultivars of *O. basilicum* and found that its quality differed significantly according to the cultivar's cropping season, plant ontogeny and plant part. The main component in one of the cultivars was methyl chavicol (84.3 - 94.3%), while the other contained methyl chavicol (62.5 - 77.6%) and linalool (14.4 - 34.1%) as the main components.

The extract of *O. basilicum* also contains reduced sugars, cardiac glycosides, tannins, saponins, glycosides, flavonoids and steroids (Dorman and Hiltunen, 2010; El-Beshbishy and Bahashwan, 2012).

The commercial value of basil is influenced by its aroma. In addition, the composition of this plant's essential oil is related to the position of the leaves on the stem. Because this position is tied to the plant's development, the plant's physiological age may be a factor that interferes in the composition of its oil (Fischer et al., 2011).

The chemical compounds isolated from *Ocimum* can have different effects on the organism, which explains the use of this plant for medicinal purposes. Table 1 summarizes the main compounds and their pharmacological effects.

MEDICINAL PROPERTIES OF *OCIMUM* SPECIES

As mentioned earlier, in many circumstances, basil is used in folk medicine to treat vomiting, intestinal colic and diarrhea, menstrual pains and sterility, improve kidney function, and to relieve the coughing, bronchitis and hoarseness that are typical of colds and flu (Bora et al., 2011). The literature contains many studies on *O. basilicum*, in addition to its uses in folk medicine. Table 2 summarizes the major known activities of *Ocimum basilicum.*

Prevention of heart diseases

Vascular diseases, which rank among the main causes of death worldwide today due to dietary changes and sedentary lifestyles, are linked to numerous risk factors such as dyslipidemia, high blood pressure, increased oxidative processes (free radicals) and inflammatory processes (Sliem et al., 2012; Barbalho et al., 2011 a).

Dyslipidemias are considered determining factors for the development of cardiovascular diseases. Elevated concentrations of plasma triglycerides, total cholesterol, and low-density lipoprotein cholesterol (LDL-c), decreased high-density lipoprotein cholesterol (HDL-c) levels, insulin resistance and hypertension lead to a group of risk factors called the metabolic syndrome, which increases the risk for vascular diseases (Savita, Sandeep, 2011).

The use of *O. basilicum* reduces the formation of foam cells in the mechanism of formation of atherosclerotic plaque because it lowers LDL-c levels by reducing its synthesis, in addition to modulating the activity of scavenger-type receptors. In Morocco, *O. basilicum* is the plant most commonly used to treat hyperlipidemia (Bravo et al., 2008). Amrani and co-workers (2006) studied this plant in animals with induced hypercholesterolemia and observed important hypolipidemic effects. Basil also exerts positive effects as a vasodilator and reduces plaque aggregation. Thus, it interferes positively in the mechanisms involved in the development of atherosclerotic disease (Benedec et al., 2007; Amrani et al., 2009).

Umar et al. (2011) investigated the effects of *O. basilicum* in renovascular hypertensive rats by evaluating blood pressure, heart weight/body weight, plasma angiotensin-II and endothelin after treating the animals with the plant. They observed lower systolic and diastolic blood pressure, reduced cardiac hypertrophy, and lower angiotensin and endothelin concentrations.

Bora et al. (2011) showed that this plant can decrease brain infarct size and lipid peroxidation and suggested that it may be useful clinically to prevent strokes.

In view of the abovementioned effects, we suggest that basil may have beneficial effects in the prevention of vascular damage.

Anti-diabetic effects

Diabetes mellitus is a syndrome associated with disorders in the metabolism of carbohydrates, lipids and proteins caused by the absolute or relative lack of insulin (ADA, 2010). The problems resulting from this disease and its complications represent a heavy burden for Brazil's Public Health Care System (SUS). Moreover, the search for medical alternatives to reduce costs may be crucial for people living below the poverty line. Thus, the use of medicinal plants represents an alternative that has been used increasingly in the treatment of diabetes and other metabolic syndrome risk factors (Mercurio et al., 2011; Barbalho et al., 2011).

A few studies have shown that other species of *Ocimum*

Table 2. Some of the pharmacological effects of *O. basilicum*

Effect reported	References
Reduction plasma lipids	Bravo et al., 2008; Amrani et al., 2009
Prevention of atherosclerosis	Benedec et al., 2007; Amrani et al., 2009
Antioxidant	Dorman and Hiltunen, 2010; Kaurinovic et al., 2011; El-Beshbishy and Bahashwan, 2012
Anti-inflammatory	Godhwani and Vyas, 1987; Rahimi et al., 2010
Anti-diabetic	El-Beshbishy and Bahashwan, 2012
Antinociceptive	Venâncio et al., 2011

have beneficial effects on glycemia (Agrawal, Rai, Singh, 1996). *O. basilicum* can also be helpful to control diabetes, possibly because it promotes inhibition of α-glucosidase and α-amylase activity (El-Beshbishy and Bahashwan, 2012).

Antioxidant, anti-inflammatory and antitumor effects

O. basilicum also has important antioxidant and anti-inflammatory effects. Its antioxidant and anti-inflammatory properties have numerous beneficial effects on the organism, for example, as a protector against endothelial lesions and cancer, preventing the occurrence of diseases that cause the highest death rates worldwide (Amrani et al., 2006; Benedec et al., 2007; Nguyen and Niemeyer, 2008; Amrani et al., 2009; Dorman and Hiltunen, 2010**;** El-Beshbishy and Bahashwan, 2012; Kaurinovic et al., 2011). The antioxidant properties of basil can be attributed to rosmarinic acid, one of the esters of caffeic acid (Tada et al., 1996; Strazzer et al., 2011), since its anti-inflammatory activity can be ascribed chiefly to the inhibition of prostaglandin biosynthesis (Godhwani and Vyas, 1987) by inhibition of the enzymes cyclooxygenase and lipoxygenase of the arachidonic acid metabolism (Singh et al., 1996). The betulinic, oleanolic, ursolic, 3-epi-maslinic, alphitolic and euscaphic acids isolated from *O. basilicum* exhibited hepatoprotective effects in rats (Marzouk, 2009). Ursolic acid has anti-inflammatory, antirheumatic, antiviral, antioxidant and antitumor properties. Silva et al. (2008) detected this acid in eight different *Ocimum* species (*O. americanum L.*, *O. basilicum L*, *O. basilicum var. purpurascens Benth.*, *O. basilicum var. minimum L*, *O. gratissimum L*, *O. micranthum Willd*, *O. selloi Benth.*, and *O. tenuiflorum L.*), and the highest content was found in *O. tenuiflorum*.

Rahimi et al. (2010) state that *O. basilicum* is also helpful in the treatment of inflammatory bowel disease, and Monga et al. (2011) observed anti-melanoma effects and radioprotective activities of different species of *Ocimum* (*O. sanctum*, *O. gratissimum*, *O. basilicum*, *O. canum*, and *O. kilimandscharicum*) in mice. They found a significant reduction in tumor volume and modulatory influence against lethal doses of gamma irradiation.

Antinociceptive effects

Venâncio et al. (2011) analyzed the chemical composition and antinociceptive effects of essential oil of *O. basilicum* L. in Swiss mice and their results showed diminished pain (by reducing abdominal contractions). These authors suggest that the peripheral and central antinociceptive effects may be associated to inhibition of the biosynthesis of pain mediators such as prostaglandins and prostacyclins.

Antimicrobial activity

Aromatic plants have been used extensively to prolong the shelf life of foods. Many studies have demonstrated that they exhibit significant properties against different microorganisms.

Sanches et al. (2010) showed that methanol extract of *O. basilicum* exhibited high antimicrobial activity, damaging the membrane of *V. cholera* and causing the death of this bacterium.

The leaf extract of basil can also exhibit antiplasmodial activity, which can be attributed to the presence of flavonoids, alkaloids, phenols, saponins, triterpenoids, glycosides, tannins and other compounds in the ethanol extract of the plant (Inbaneson et al., 2012).

The essential oils of many species of *Ocimum* (including *O. basilicum*) exert antibacterial (against Gram-positive and Gram-negative bacteria such as *Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus mutans*, and *Enterococcus faecalis*) and antifungal effects (*Epidermophyton floccosum*, *Microsporum gypseum*, and *Sporothrix schenckii* (Rao et al., 2011).

Rattanachaikunsopon and Phumkhachorn (2010) used basil essential oil against *Salmonella* in vitro and in food and concluded that it can be used as an antimicrobial agent to control *S. Enteritidis* in food.

So far there is no evidence of a potential clinical use for essential oils of *O. basilicum* and many studies are necessary to determine if they could substitute synthetic antibiotics or be used in combination with them (Alexopoulos et al., 2011).

CONCLUSION

Like other species of basil, *Ocimum basilicum* is used by the pharmaceutical, food and aroma industries due to its chemical constituents such as essential oils. It is also widely used in folk medicine and as an edible plant. Several studies have identified the bioactive compounds of this plant and demonstrated its beneficial physiological and metabolic properties, indicating that it may be useful for the prevention or treatment of many ailments.

The medicines normally employed to regulate glycemia, dyslipidemia and other metabolic disorders are expensive; hence, the use of basil may be an alternative low-cost strategy for their treatments.

CONFLICT OF INTEREST

The authors have no conflicting financial interests.

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